Detection of Gossans in Sonora (Mexico) with the Use of Remote Sensing Techniques

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Gossans and alteration zones often led to economic concentrations of metals. Their detection on satellite images, which is the aim of this study, can help in prospecting for metal deposits, especially in relatively unexplored areas. Also, the study attempted to find the methods which would be optimal for obtaining geological information from remotely sensed imagery on territories with similar climatic, geological, and topographical characteristics.

The field of the study is located in Sonora (NW state of Mexico), about 140 km NE of state's capital city of Hermosillo, and it is a rectangle of the area about 700 km^2. It lies in the Basin and Range Province, which is mainly composed of late-Cretaceous - Miocene volcano-sedimentary sequences forming elevations and poorly consolidated Pliocene and younger sedimentary rocks filling valleys. Locally, there are outcrops of Laramide intrusions. Styles of mineralization in the state are primarily copper porphyry, epithermal, and skarn connected with the Laramide orogeny (Ochoa-Landín *et al.*, 2011). The field, located near the eastern edge of the Sonoran Desert at the western margin of Sierra Madre Occidental, is sparsely vegetated by arid scrubs.

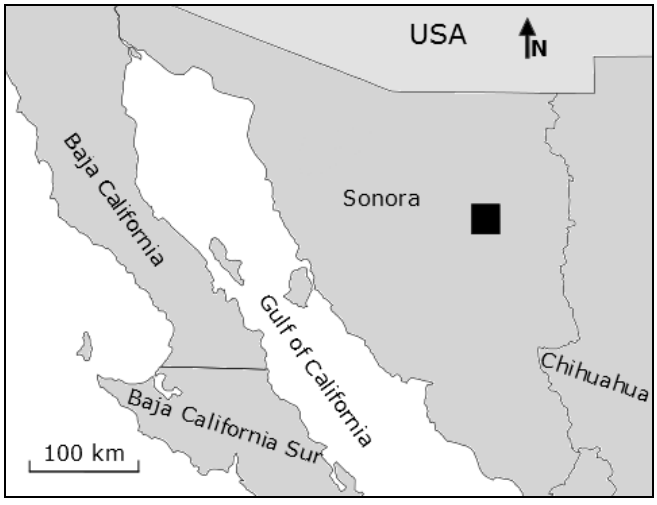

Fig 1.: Location of the field of study (the black rectangle)

Multispectral satellite imagery from ETM+ (Landsat 7) and ASTER (Terra) instruments, digital elevation model ASTER GDEM, as well as 1:50 000 geological map published by the Mexican Geological Survey were used in the study. Space-borne imagery was obtained at a time of relatively poor development of vegetation to reduce its influence on rock and ground spectra (March 2003 and February 2006 for ETM+ and ASTER, respectively).

In the research area, there is a known example of a gossan used for analysing its spectral response and comparison with other objects. It is called Tabisco Gossan, which is a product of weathering of a low sulphidation epithermal gold-silver system. It is dominantly composed of a mixture of Fe oxides and hydroxides (limonite) with clay and other secondary minerals in lesser amounts (Taylor, 2012).

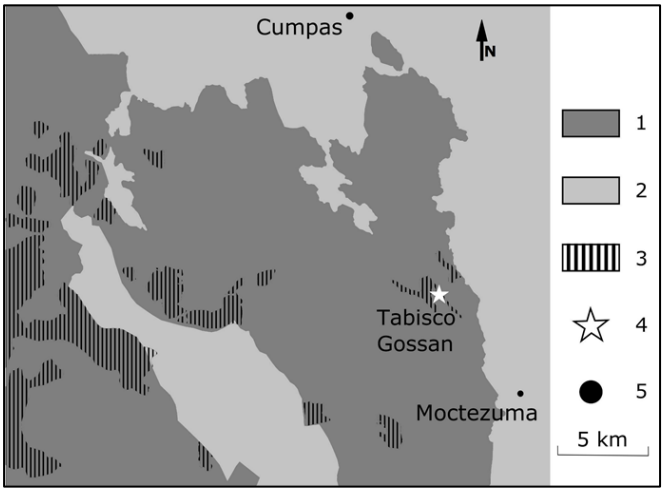

Fig 2.: Schematic geological map of the study area (based on Cumpas H12-D14, Carta Geológico Mexicano, Servicio Geológico Mexicano 2006)
1) late-Cretaceous - Miocene volcano-sedimentary rocks, 2) Pliocene-Holocene sedimentary rocks, 3) alteration zone, 4) test field gossan, 5) town

The analysis of the satellite imagery included colour composites, band ratios, and other methods visually enhanced with image processing operations. Additionally, the detection of the lineaments, as well as assessment of their geological significance, was performed by means of visual interpretation and image enhancement techniques on satellite imagery and DEM. With the unsupervised ISODATA classification of ETM+ data, classification maps have been produced. Their groundtruthing was done with the geological map and tested with the use of statistical methods.

The methods applied revealed occurrence of areas with high ferric oxide content connected with alteration zones, which probably are closely related to gossans.

Taylor, R. (2012) Gossans and Leached Cappings: Field Assessment, Springer, Berlin, pp. 146.

Ochoa-Landín, L., Pérez-Segura, E., Del Río-Salas, R., Valencia-Moreno, M. (2011) : Instituto de Geología, Boletín, 118: 299–331.

Servicio Geológico Mexicano. Cumpas H12-D14, Sonora [map]. 1:50,000. Carta Geológico Mexicano, Pacucha, Hgo., México: SGM, 2006